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Wetlands Research Program Technical Report WRP-RE-7

Comparison of Abundance and Diversity of Young Fishes and Macroinvertebrates between Two Lake Erie Wetlands

by Eric D. Dibble, Jan J. Hoover, Mary C. Landin



April 1995 – Final Report

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	Task		Task
CP	Critical Processes	RE	Restoration & Establishment
DE	Delineation & Evaluation	SM	Stewardship & Management

Wetlands Research Program

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U.S. Army Corps of Engineers
Waterways Experiment Station
3909 Halls Ferry Road
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Final report

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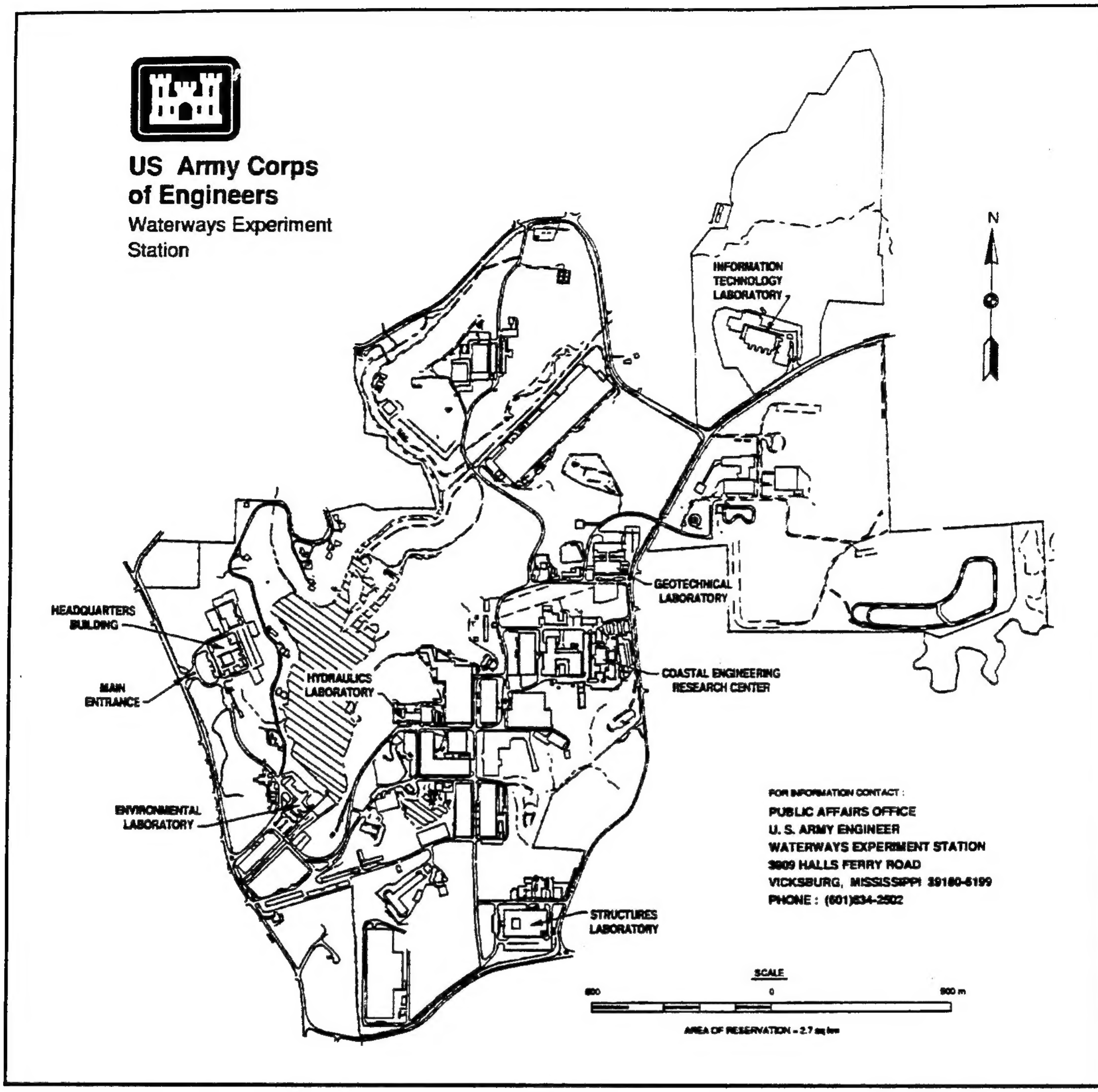

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Fisheries Habitat

Comparison of Abundance and Diversity of Young Fishes and Macroinvertebrates between Two Lake Erie Wetlands (TR WRP-RE-7)

ISSUE:

Lake Erie wetlands are important nurseries for fishes, but quantitative descriptions of fish-habitat relationships are uncommon. Synoptic field surveys allow associations between food resources (macroinvertebrates), microhabitats, and abundance of recently spawned fishes to be identified. These relationships can be used to predict impacts of wetland alteration and to develop guidelines for wetland management and construction.

RESEARCH:

Composition of recently spawned larval and juvenile fishes and macroinvertebrates were compared between two Lake Erie Wetlands located at Pointe Mouillee, MI, USA (man-made wetland), and Point Pelee, Ontario, Canada (natural wetland). Light traps were used to measure abundance and diversity of larval fishes and macroinvertebrates, and seines were used to quantify juvenile fishes. Samples were collected during three periods (April and June 1993, and June 1994).

SUMMARY:

Fish assemblages differed significantly between wetlands. At Pointe Mouillee, larval fishes were more abundant, speciose, and diverse than at Point Pelee; juvenile fishes were also more abundant and speciose at the man-made wetland. Assemblages at Pointe Mouillee were dominated by common carp, yellow perch, sunfishes, and gizzard shad, and assemblages at Point Pelee were dominated by sunfishes, largemouth bass, black bullhead, and golden shiners.

Species richness and diversity of macroinvertebrates were comparable between wetlands, but abundance was lower at Pointe Mouillee than at Point Pelee. Assemblages at Pointe Mouillee were dominated by bugs (water boatmen), and assemblages at Point Pelee were dominated by crustaceans (water fleas, seed shrimp, scuds).

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About the Authors:

Dr. Eric D. Dibble is an aquatic ecologist, Dr. Jan J. Hoover is an ichthyologist, and Dr. Mary C. Landin is a research biologist at the WES Environmental Laboratory. Point of contact at WES is Dr. Hoover, Phone: (601) 634-3996, EMAIL: HOOVER@EX1.WES.ARMY.MIL.

Contents

List of Figures

List of Tables

Preface

The work described in this report was authorized by Headquarters, U.S. Army Corps of Engineers (HQUSACE), as part of the Restoration and Establishment of Wetlands Task Area of the Wetlands Research Program (WRP). The work was performed under Work Unit 32761, "Wetlands Field Demonstrations and Research," for which Dr. Mary C. Landin was the Technical Manager. Ms. Denise White (CECW-ON) was the WRP Technical Monitor for this work.

Mr. Dave Mathis (CERD-C) was the WRP Coordinator at the Directorate of Research and Development, HQUSACE; Dr. William L. Klesch (CECW-PO) served as the WRP Technical Monitors' Representative; Dr. Russell F. Theriot, U.S. Army Engineer Waterways Experiment Station (WES), was the Wetlands Program Manager. Dr. Landin was the Task Area Manager.

This report was prepared by Drs. Eric D. Dibble, Jan J. Hoover, and Landin, Ecological Research Division (ERD), Environmental Laboratory (EL), WES, under the general supervision of Dr. Conrad J. Kirby, Chief, ERD, EL. Dr. Edwin A. Theriot was the Assistant Director, EL, and Dr. John W. Keeley was Director, EL.

Appreciation goes to Mr. Rex Ainslie, Michigan Department of Natural Resources at Pointe Mouillee State Game Area, and Mr. Gary Mouland, Canadian Park Service at Point Pelee National Park, for their support. We also thank Dr. K. Jack Killgore for his comments on the manuscript, and Mr. Chris Kall, Ms. LeAnn Agnew, and Messrs. Larry Sanders, Steven George, Keith Gerdes, and Jim Morrow for their help in the field, and Dr. Craig Smith for his help with aquatic plant identification. A special thanks goes to Mr. Steven George for his work and expertise on invertebrates and to Mr. Bob Wallus for his identification of the larval fishes.

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1 Introduction

Background

Shallow wetlands are essential in the early life history of a number of fish species (Jaworski and Raphael 1978) and are important as nursery grounds for fishes of inland lakes including transient Great Lake species (Mansfield 1984). Inland and coastal wetlands are important for fish production, because they contain shallow water habitats and aquatic plants used by spawning adults and by young fishes for growth and survival (Priegel 1970, Fago 1977, Mansfield 1984, and Liston et al. 1985). Aquatic plant beds in these shallow water habitats provide habitat diversity (Savitz 1981), complexity (Crowder and Cooper 1982), protection (Mittelbach 1981, Werner, Hall, and Werner 1978, Savino and Stein 1982), and food (Pardue and Nielsen 1979, Gilinsky 1984, Keast 1985).

The Western Basin of Lake Erie once contained an extensive system of coastal marshes that served as spawning areas and nursery grounds for many different fish species. Today, many of these fish species have been reduced in number or have been extirpated (Trautman 1976). Reduction in fish populations is partially attributed to loss of aquatic plants and spawning and nursery habitats, due to alteration of coastal wetlands. Great Lake coastal areas not preserved and maintained as wetlands are now either drained and managed for agriculture or urbanized and contain little original vegetation and habitat (Great Lakes Basin Commission 1975).

Coastal wetlands likely harbor greater numbers of young fishes than previously reported, emphasizing the importance of such areas to the ecology of the Great Lakes (Chubb and Liston 1986). Comparison in abundance and diversity of young fishes between altered and unaltered wetlands is one approach to understand anthropogenic impacts on wetland fish communities (Poe et al. 1986). However, previous larval fish studies have been largely confined to limnetic waters because of difficulty in obtaining quantitative samples in shallow areas congested with vegetation (Amundrud, Faber, and Keast 1974). Larval drift has been studied extensively, yet little data are available from highly vegetated wetland habitats (Chubb and Liston 1986, Paller 1987).

Goal and Objectives

Our goal in this study was to accumulate baseline data on young fishes in two Lake Erie wetlands and quantify habitat differences between the wetlands that influence fish community structure. This study meets the following objectives: (a) measures and compares differences in abundance and diversity of larval and juvenile fishes between two Lake Erie wetlands, (b) quantifies differences in food availability by measuring and comparing abundance and diversity of macroinvertebrates between these two wetlands, and (c) determines microhabitat differences between the two wetlands by measuring and comparing physical parameters important to young fishes.

2 Study Sites

Pointe Mouillee and Pelee wetlands are located in the Western Basin of Lake Erie (Figure 1) and were chosen for study because of their close proximity and differences in alteration status. Both wetlands are usually isolated from Lake Erie to protect and reduce runoff impacts on the wetlands and also due to natural causes. Drainage ditches and dikes have been constructed at both sites to prevent direct agricultural runoff or river flow into the wetland. The waters of Pointe Mouillee are managed via a system of dikes, pumps, and gates. The wetland is connected to the main lake only when gates are open along the dike. The wetland at Point Pelee, isolated from Lake Erie by a natural sand beach, is connected only when high waves from Lake Erie occur (Canadian Park Service, personal communication).

Pointe Mouillee, Michigan, USA

Pointe Mouillee wetland contains approximately 1,500 ha of marsh and is located along Michigan's eastern shore where Mouillee and Huron Rivers drain into Lake Erie. Similar to many other coastal wetlands, Pointe Mouillee has been severely altered by years of erosion and flooding. The coastal marshes at Point Mouillee in the past have been protected by barrier islands which have since eroded and left the wetlands exposed. As a result, wetland habitat at Point Mouillee was in danger of disappearing because of increased erosion due to shipping traffic and flooding of the marsh.

In 1974, the U.S. Army Engineer District, Detroit, in cooperation with the Michigan Department of Natural Resources (MDNR), built a 365-ha containment dredge facility (CDF) to hold dredged material (Landin 1993). In addition to containing dredge material, it also serves as a barrier island that protects the wetlands and promotes recovery. Since construction of the CDF, much submersed aquatic vegetation at Pointe Mouillee has rejuvenated. As evidence of its recent disturbance, most of the emergent vegetation in the wetland is dominated by the exotic reed (*Phragmites australis*).

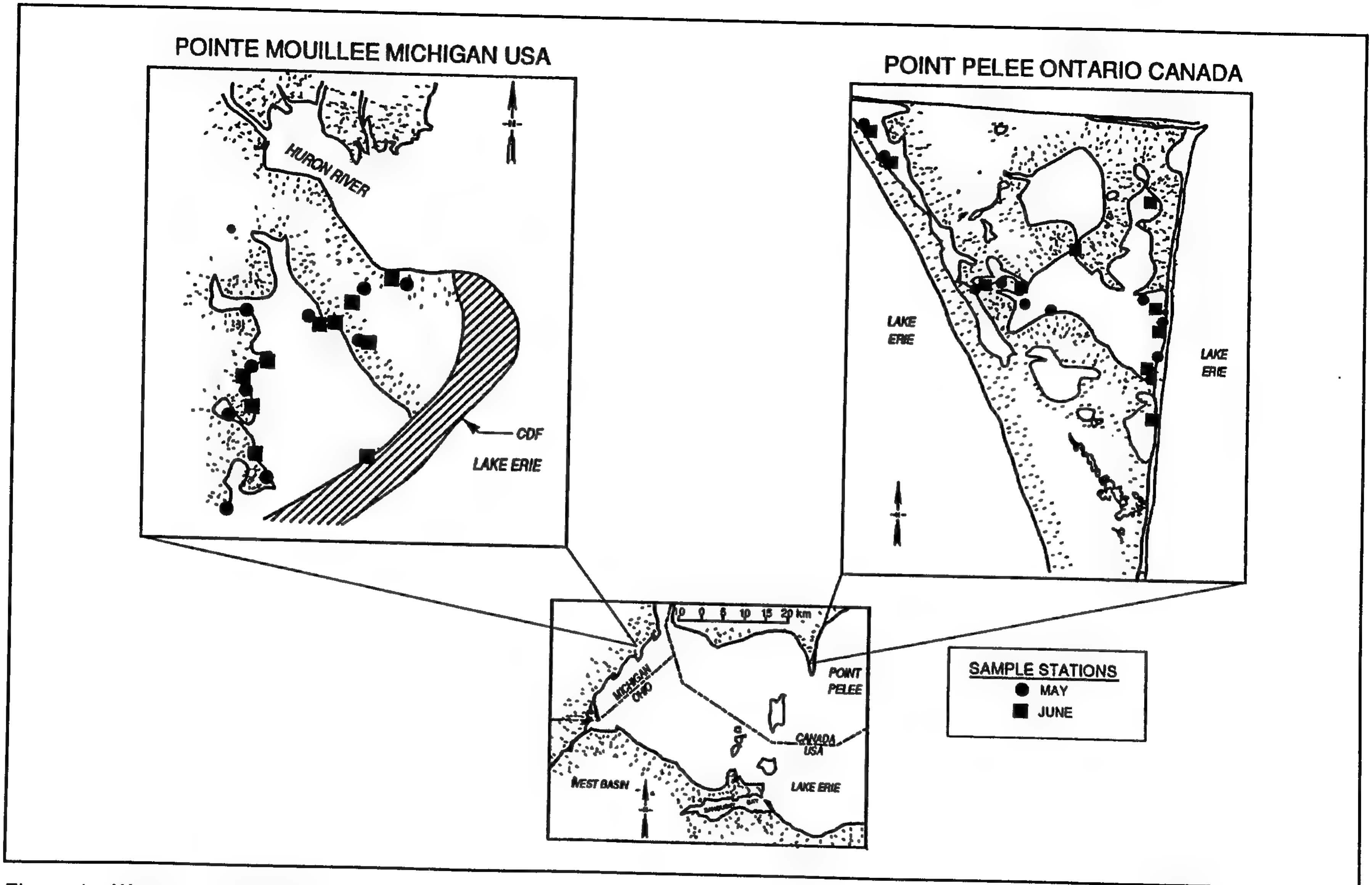

Figure 1. Western Lake Erie and location of sample stations in the two wetland study sites (CDF = Containment Dredge Facility)

Point Pelee, Ontario, Canada

Point Pelee wetland is located in Canada on a narrow peninsula extending south from the northwestern shore of Lake Erie. Pointe Pelee contains approximately 1,100 ha of relatively unaltered marshes. The wetland is maintained and separated from agricultural land by an earthen dike, extensive cattail beds, and a channel which diverts water away from the wetland (McCrea, Schito, and Struges 1991). The wetland is protected from Lake Erie waves by a sand beach which only infrequently breaks from large storms. Because the wetland is located several miles from major shipping lanes, little or no erosion has occurred, and submersed aquatic plants are abundant. Emergent vegetation in the wetland is dominated by cattail beds (*Typha angustifolia*).

3 Methods

Larval fishes

Wetlands contain highly vegetated areas important to larval fishes (Gregory and Powles 1985, Paller 1987), yet shallow habitats congested with vegetation are difficult to sample with traditional methods, i.e., nets and trawls (Freeman, Greening, and Oliver 1984). To circumvent this problem, we used a modified light trap (after Killgore 1993). Internal dimensions of the trap were approximately 170 by 50 mm, with four openings of 200 by 5 mm. During three sample periods (April 1993, June 1993 and 1994), traps were placed in 8 to 11 randomly choosen sample stations located at each wetland (Figure 1). Four traps were lighted with 12-hr, Cyalume chemical sticks and placed in two transects perpendicular to the shoreline (Figure 2). During each sample period, traps were set for 2 nights, from approximately 2 hr before sunset to 2 hr after sunrise. Eight trap nights were conducted per station at each wetland during sample periods. A total of 232 trap nights were conducted at Point Pelee, and 216 trap nights at Pointe Mouillee. Larval fishes were removed from the traps and preserved in vials containing 5-percent formalin and sent to laboratory for identification.

Juvenile fishes

A modified Breder (1960) trap and seines were used to collect juvenile fishes (Hayes 1989). The trap was made of clear Plexiglas with dimensions measuring approximately 450 by 180 by 170 cm. One end contained two Plexiglass pieces forming a funnel with an opening measuring 150 by 2 cm. Two traps were placed 48 hr in each sample station (Figure 1) and checked twice during this period. Equal seining efforts were conducted in both wetlands. When conditions permitted, seines (approximately 3.1 by 1.8 m; 10-mm mesh) were used at sample stations (Figure 2). Five seine hauls (approximately 10 m in length parallel to the shoreline) were conducted at each site. For each wetland, seven to nine seining sites were used during each sample period to complete a total of 130 hauls. All adult and most older juvenile fishes were identified in the field and released.

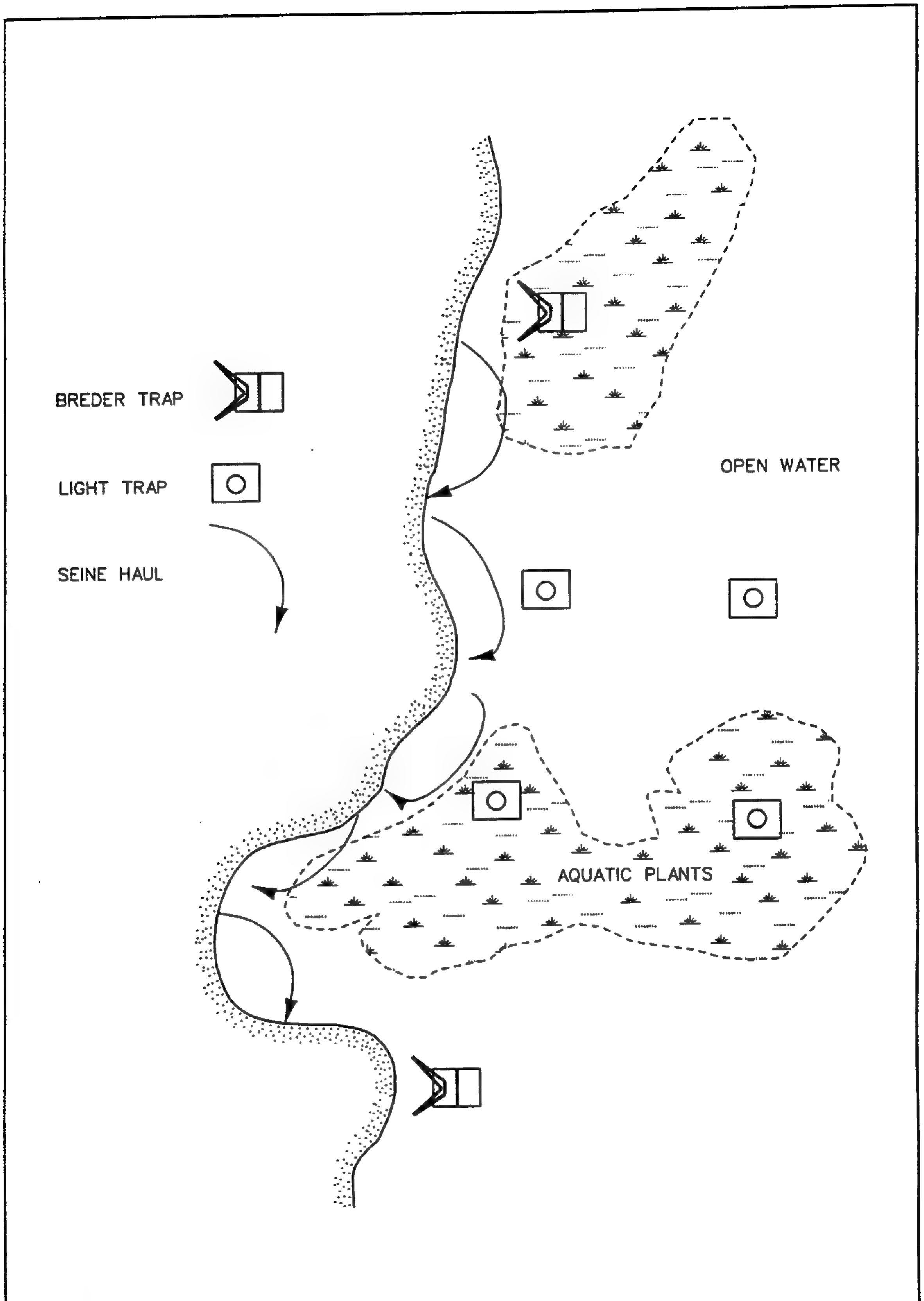

Figure 2. Example of larval and juvenile trap placements and seine locations at a sample station

Smaller juvenile fishes were preserved in 10-percent formalin and brought back to laboratory for identification.

Macroinvertebrates

Food resources for fishes were quantified in each wetland by measuring abundance and diversity of macroinvertebrates. Macroinvertebrate samples were collected from the light traps during the first trap night of each sample period. Thus, 116 trap nights were used for the sample at Point Pelee and 208 trap nights at Pointe Mouillee. Macroinvertebrates were preserved in 5-percent formalin and transported to a laboratory where they were counted and identified to the nearest taxa (after Pennak 1989, Thorp and Covich 1991).

Microhabitat

A variety of microhabitat parameters important to fishes were measured in both wetlands. Mean values for pH, water clarity (cm), temperature (°C), dissolved oxygen (ppm), turbidity (*NTU's*), total dissolved solids (ppm), depth (m), and distance (m) from shore were determined for each sample station. Secchi disc was used to determine water clarity; water temperature, pH, and TDS were determined at near-surface location with thermometers and hand-held probes (Models 60648 and 1491-62, Cole Parmer, Chicago, IL). Near-surface measurements of dissolved oxygen were gauged with a test kit (HACH, Loveland, CO), and turbidity was determined with a portable turbidity meter (Model 2100P HACH, Loveland, CO). Water depth and distance from the nearest shoreline were measured at stations with a stadia rod; distances greater than 10 m were estimated. Percentage of aquatic plant cover was determined at each station by recording presence and absence of aquatic plants. Plant type also was recorded; identification was based on Prescott (1980) and Muenscher (1969).

Analysis

Relative percent abundance of larval and juvenile fishes and macroinvertebrates were compared between Pointe Mouillee and Point Pelee wetlands. Species diversity of larval and juvenile fishes and macroinvertebrates was calculated for each wetland with a Shannon-Wiener index: $H' = -\Sigma p_i \log p_i$ (Brewer and McCann 1982). Significant interwetland differences in larval and juvenile fish, invertebrate abundance, and physical parameters were evaluated by a one-way AOV (Siegel 1994).

Differences in microhabitat at the two wetlands also were evaluated using principal components analysis (SAS Institute 1990).

4 Results

Larval fishes

A total of 2,962 larval fishes was collected from the two wetlands; 1,910 larvae from Pointe Mouillee wetlands and 1,052 larvae from Point Pelee (Table 1). Species diversity for larval fishes differed between wetland sites; 21 taxa ($H' = 2.042$) were collected at Pointe Mouillee and 16 taxa ($H' = 1.137$) were collected at Point Pelee.

Relative percent abundance of larval fishes significantly differed between the wetlands ($F=2.5$, $P<0.05$) (Figure 3). Cyprinids dominated and represented 42.2 percent of the sample from Pointe Mouillee, where centrarchids (65.5 percent) dominated Point Pelee samples. Centrarchids represented only 25.5 percent of fishes collected at Pointe Mouillee, and cyprinids represented only 8.8 percent of the fishes sampled in Point Pelee. Common carp (*Cyprinus carpio*) dominated the larval cyprinids at Pointe Mouillee (Table 1), and smaller sunfishes (*Lepomis* sp.) constituted most centrarchids at both wetlands.

Compared to Pointe Mouillee, ictalurids were relatively high in abundance at Point Pelee. Ictalurids represented over 20 percent of fishes collected from Point Pelee wetlands, where they composed <1 percent of fishes sampled at Pointe Mouillee. Black bullheads (*Ameiurus melas*) dominated the ictalurids at Point Pelee (Table 1). Catostomidae constituted 7.1 percent of the fishes collected at Pointe Mouillee, where they represented <1 percent in Point Pelee. Most catostomids at Point Mouillee were buffalo (*Ictiobus* sp.), quillback (*Carpiodes cyprinus*), and unidentified catostomids (Table 1). Atherinids and percids percentages were relatively similar between the wetlands (Figure 3).

Juvenile fishes

Total abundance of juvenile fishes differed between the two Lake Erie wetlands; 1,229 juveniles were collected at Pointe Mouillee, whereas only 395 fish were taken from Point Pelee wetlands (Table 1). Species

Table 1
Differences in Abundance and Relative Percentages of Juvenile and Larval Fishes between Lake Erie Wetlands (April 1993, June 1993 and 1994)

	Pointe Mouillee				Point Pelee			
	Juvenile		Larval		Juvenile		Larval	
Families/Species	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)
Amiidae								
Amia cava, Bowfin	1	0.1	0	0	0	0	0	0
Clupeidae								
Dorosoma cepedianum, Gizzard shad	9	0.7	426	22.3	0	0	1	0.1
Unidentified Clupeids	0	0	19	1.0	0	0	6	0.6
Cyprinidae								
Carassius auratus, Goldfish	110	9.0	36	2.0	0	0	0	0
Cyprinus carpio, Common carp	289	23.5	427	22.4	1	0.3	49	4.7
Cyprinella spiloptera, Spotfin shiner	1	0.1	0	0	0	0	0	0
Luxilus cornutus, Common shiner	1	0.1	0	0	0	0	0	0
Notemigonus crysoleucas, Golden shiner	1	0.1	0	0	69	17.5	35	3.3
Notropis atherinoides, Emerald shiner	10	0.8	31	1.6	0	0	0	0
Notropis heterolepis, Blacknose shiner	0	0	10	0.5	3	0.8	0	0
Notropis hudsonius, Spottail shiner	7	0.6	33	1.7	0	0	0	0
Notropis volucellus, Mimic shiner	0	0	0	0	1	0.3	0	0
Notropis sp., Unidentified shiner	0	0	59	3.1	0	0	0	0
Pimephales notatus, Bluntnose minnow	31	2.5	0	0	14	3.6	0	0
Pimephales promelas, Fathead minnow	81	6.5	0	0	0	0	0	0
Unidentified Cyprinids	0	0	210	11.0	0	0	5	0.5
Catostomidae								
Carpiodes cyprinus, Quillback	0	0	34	1.8	0	0	3	0.3
Catostomus sp., Unidentified sucker	0	0	2	0.1	0	0	0	0
Erimyzon sucetta, Lake chubsucker	0	0	0	0	0	0	2	0.2
Ictiobus cyprinellus, Bigmouth buffalo	48	4.0	0	0	0	0	0	0
Ictiobus sp., Unidentified buffalo	0	0	43	2.3	0	0	0	0
Moxostoma sp., Unidentified redhorse	0	0	1	0.1	0	0	0	0
Unidentified Catostomids	0	0	57	3.0	0	0	0	0
Ictaluridae								
Ameiurus melas, Black bullhead	12	1.0	0	0	0	0	234	22.2
Ameiurus nebulosus, Brown bullhead	0	0	1	0.1	0	0	1	0.1
Ictalurus punctatus, Channel catfish	1	0.1	0	0	0	0	0	0
Noturus gyrinus, Tadpole madtom	12	1.0	0	0	1	0	0	0
Esocidae								
Esox americanus, Grass pickerel	0	0	0	0	15	3.8	0	0
Umbridae								
Umbra limi, Central mudminnow	1	0.1	0	0	32	8.1	0	0
Cyprinodontidae								
Fundulus diaphanus, Banded killifish	1	0.1	0	0	0	0	0	0
Atherinidae								
Labidesthes sicculus, Brook silverside	11	0.9	32	1.7	5	1.3	14	1.3
Gasterosteridae								
Gasterosteus aculeatus, Threespine stickleback	1	0.1	0	0	0	0	0	0

(Continued)

Table 1 (Concluded)								
	Pointe Mouillee				Point Pelee			
	Juvenile		Larval		Juvenile		Larval	
Families/Species	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)
Centrarchidae								
Ambloplites rupestris, Rock bass	0	0	0	0	0	0	1	0.1
Lepomis cyanellus, Green sunfish	39	3.2	0	0	0	0	0	0
Lepomis gibbosus, Pumpkinseed	28	2.3	0	0	29	7.4	5	0.5
Lepomis gulosus, Warmouth	0	0	0	0	11	2.8	0	0
Lepomis humilus, Orangespotted sunfish	9	0.7	0	0	0	0	0	0
Lepomis macrochirus, Bluegill	46	3.7	0	0	52	13.2	0	0
Micropterus salmoides, Largemouth bass	44	3.6	4	0.2	126	32.0	10	1.0
Pomoxis annularis, White crappie	3	0.2	0	0	1	0.3	0	0
Pomoxis nigromaculatus, Black crappie	2	0.2	1	0.1	0	0	1	0.1
Pomoxis sp., Unidentified crappie	0	0	8	0.4	0	0	0	0
Lepomis sp., Unidentified sunfish	0	0	474	24.8	0	0	648	61.6
Percidae								
Etheostoma exile, Iowa darter	0	0	0	0	1	0.3	0	0
Perca flavescens, Yellow perch	430	35.0	2	0.1	34	8.6	1	0.1
Sciaenidae								
Aplodinotus grunniens, Freshwater drum	1	0.1	0	0	0	0	0	0
Unidentified sp.	0	0	0	0	0	0	36	3.4
Totals	1,229		1,910		395		1,052	

diversity was similar in both wetlands; 27 species ($H' = 2.105$) were collected at Pointe Mouillee, and 16 species ($H' = 2.052$) were sampled at Point Pelee.

Significant difference ($F = 3.47$, $P < 0.01$) in the relative abundance of juvenile fishes was noted between the two wetlands (Figure 4). Cyprinids and percids dominated the juvenile fishes collected at Pointe Mouillee. Cyprinidae represented 43.8 percent, and Percidae represented 35 percent of the total juvenile fishes sampled; centrarchids dominated fishes sampled in Point Pelee wetlands, representing over 55 percent of all juvenile fishes collected (Figure 4).

Individual species of juvenile minnows collected at Pointe Mouillee differed from those collected at Point Pelee (Figure 5). Common carp (*Cyprinus carpio*) and goldfish (*Carassius auratus*) dominated the juvenile cyprinids sampled at Pointe Mouillee. Fathead minnow (*Pimephales promelas*), bluntnose minnow (*P. notatus*), spottail shiner (*Notropis hudsonius*), and emerald shiner (*N. atherinoides*), represented 21, 15.1, 5.8, 1.3, and 2 percent, respectively. Of these cyprinids, golden shiner (*Notemigonus crysoleucas*), spotfin shiner (*Cyprinella spiloptera*), and common shiner (*Luxilus cornutus*), represented <1 percent. Of the juvenile cyprinids collected at Point Pelee, golden shiner (*Notemigonus crysoleucas*) was dominant representing over 78 percent of this sample, whereas, common carp (*C. carpio*) represented only 1.1 percent of this

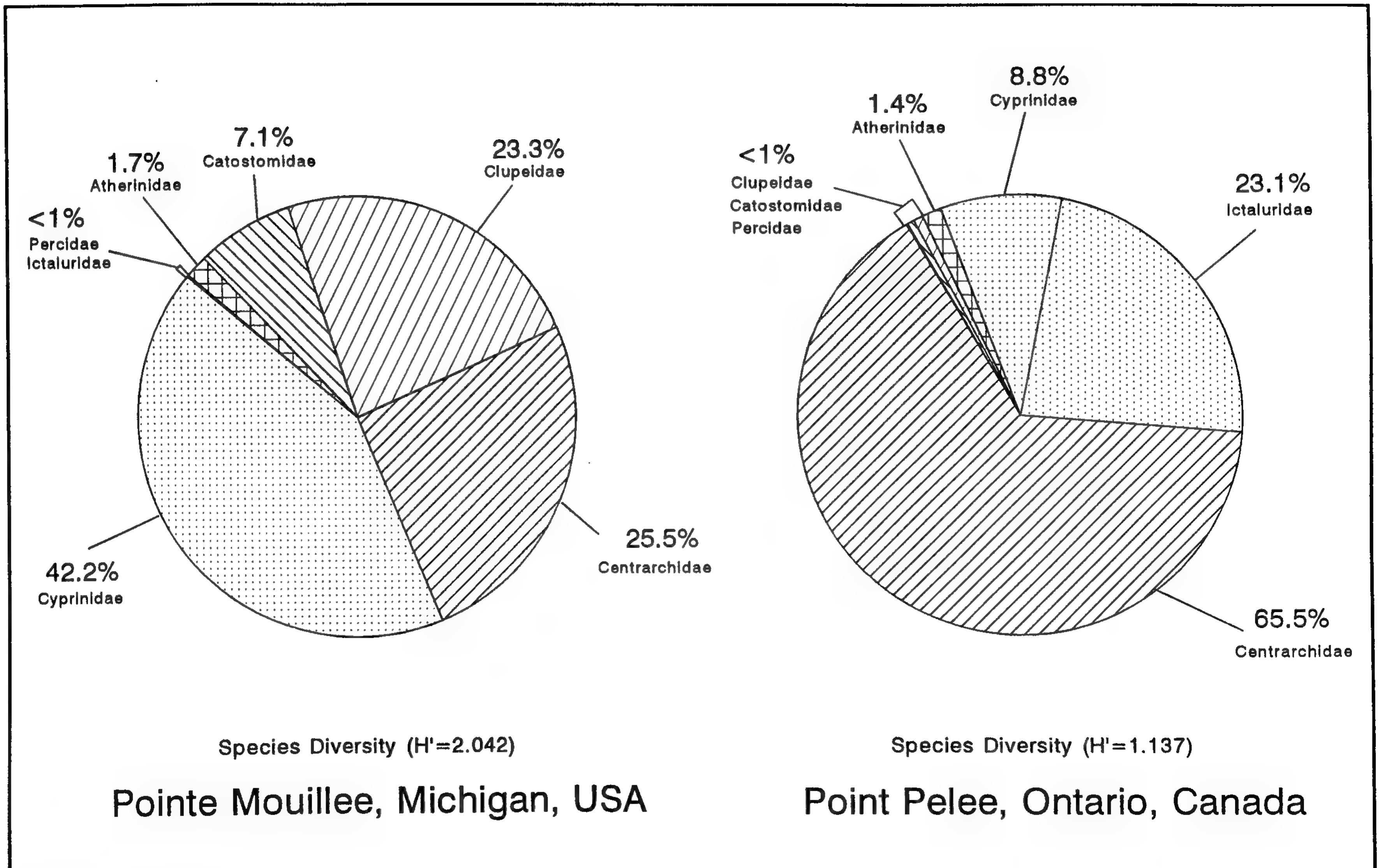

Figure 3. Differences in relative percent abundance of larval fishes between Lake Erie wetlands

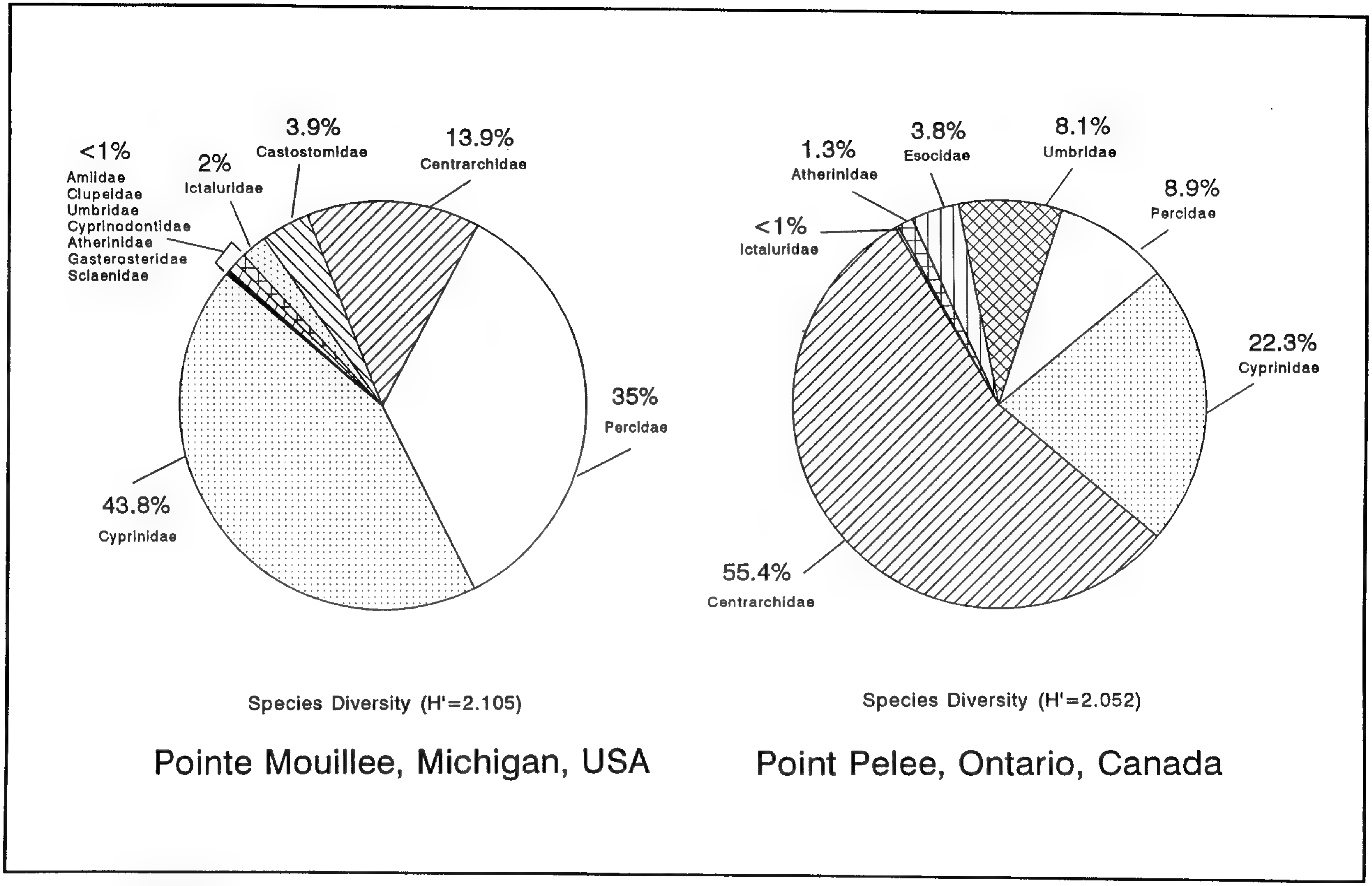

Figure 4. Differences in relative percent abundance of juvenile fishes between Lake Erie wetlands

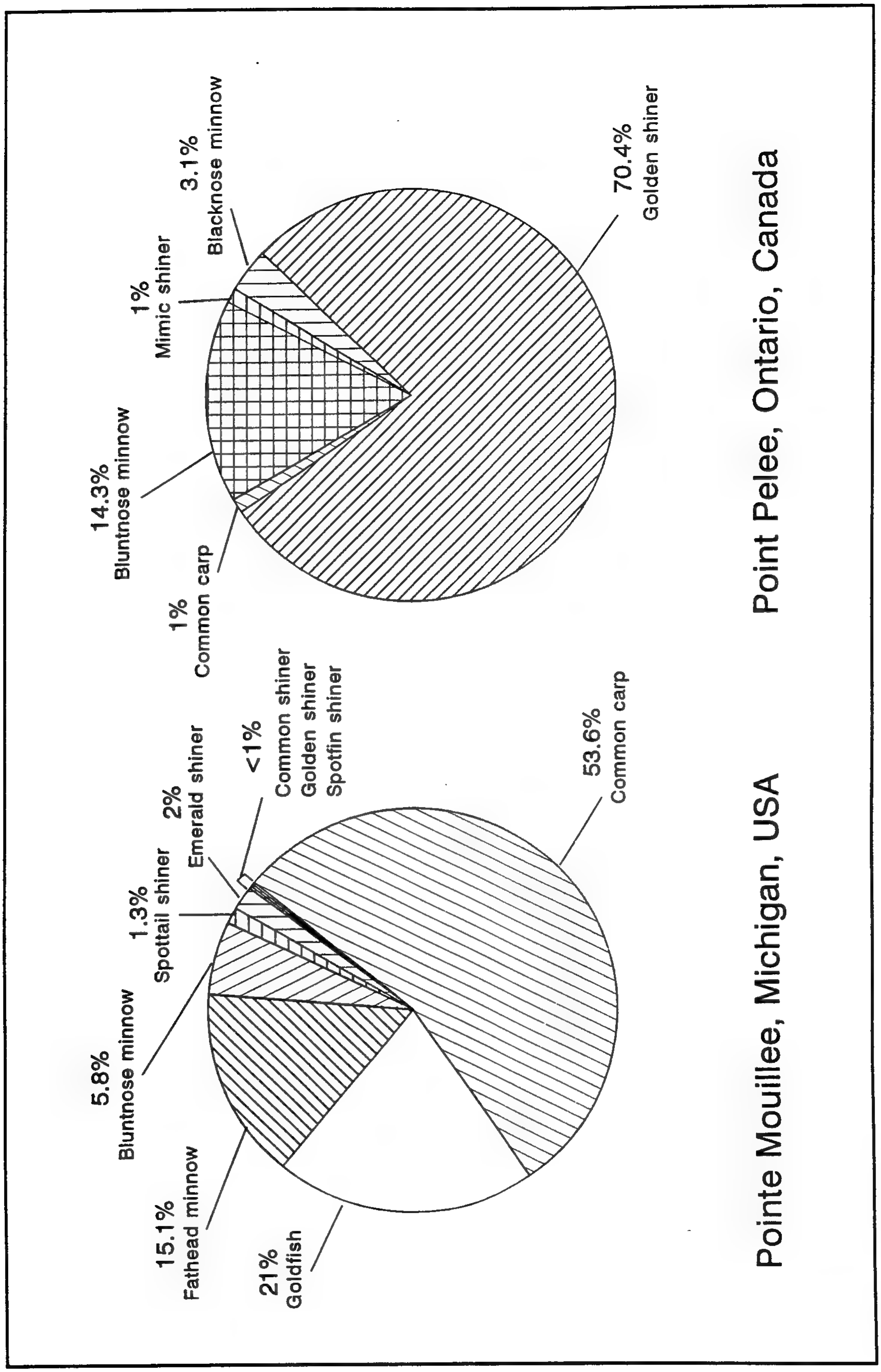

Figure 5. Differences in relative percent abundance of minnows (Cyprinidae) between Lake Erie wetlands

sample and no goldfish (*C. auratus*) were collected. Bluntnose minnow (*P. notatus*) represented 15.9 percent of the sample. Cyprinids sampled from Point Pelee lacked fathead minnows and common, spotfin, emerald, and spottail shiners but contained two species that were not collected at Pointe Mouillee: mimic shiner (*Notropis volucellus*) and blacknose shiner (*N. heterolepis*). Blacknose minnow and mimic shiner represented 3.4 and 1.1 percent, respectively.

Individual species of juvenile centrarchids also varied in abundance between the two wetlands (Figure 6). Largemouth bass (*Micropterus salmoides*) dominated the centrarchids sampled at Point Pelee with 57.5 percent, whereas, only 25.7 percent of this sample at Pointe Mouillee contained juvenile largemouth bass. Abundances of bluegill sunfish (*Lepomis macrochirus*) and pumpkinseed (*L. gibbosus*) were similar at both wetlands. At Pointe Mouillee, bluegill and pumpkinseed represented 29.9 and 16.4 percent, respectively, and at Point Pelee, bluegill and pumpkinseed made up 23.7 and 13.2 percent of the sample, respectively. White and black crappie (*Pomoxis annularis* and *P. nigromaculatus*) represented <2 percent in relative abundance. Only white crappie was collected at Point Pelee. Warmouth (*L. gulosus*), but not green sunfish (*L. cyanellus*), were found at Point Pelee, and green sunfish, but not warmouth, were collected at Pointe Mouillee. Warmouth represented 5 percent of the sample at Point Pelee, and green sunfish made up 22.8 percent of sunfishes collected at Pointe Mouillee.

Macroinvertebrates

Total abundance and diversity of macroinvertebrates varied between the two wetlands. A total of 9,608 macroinvertebrates was collected at Pointe Mouillee, 28,998 at Point Pelee (Table 2). Species diversity was higher at Point Pelee than at Pointe Mouillee, 49 taxa ($H' = 2.379$) and 48 taxa ($H' = 2.056$), respectively.

Differences in abundance of macroinvertebrates between the two wetlands were highly significant ($F = 571.33$, $P < 0.001$) (Figure 7). Hemiptera (water bugs) dominated Pointe Mouillee sample, and Cladocera (water fleas), Ostracoda (seed shrimp), and Amphipoda (scuds) constituted much of the Point Pelee sample. Corixidae (water boatman) was the most common hemipteran, representing over 50 percent of all invertebrates collected at Pointe Mouillee (Table 2). Of the invertebrates collected at Point Pelee, the family Sididae constituted most of the Cladocera, and *Hyalella azteca* dominated the amphipods. Relative abundance of Diptera at Pointe Mouillee and Point Pelee were similar, 6.8 and 6.5 percent, respectively (Table 2).

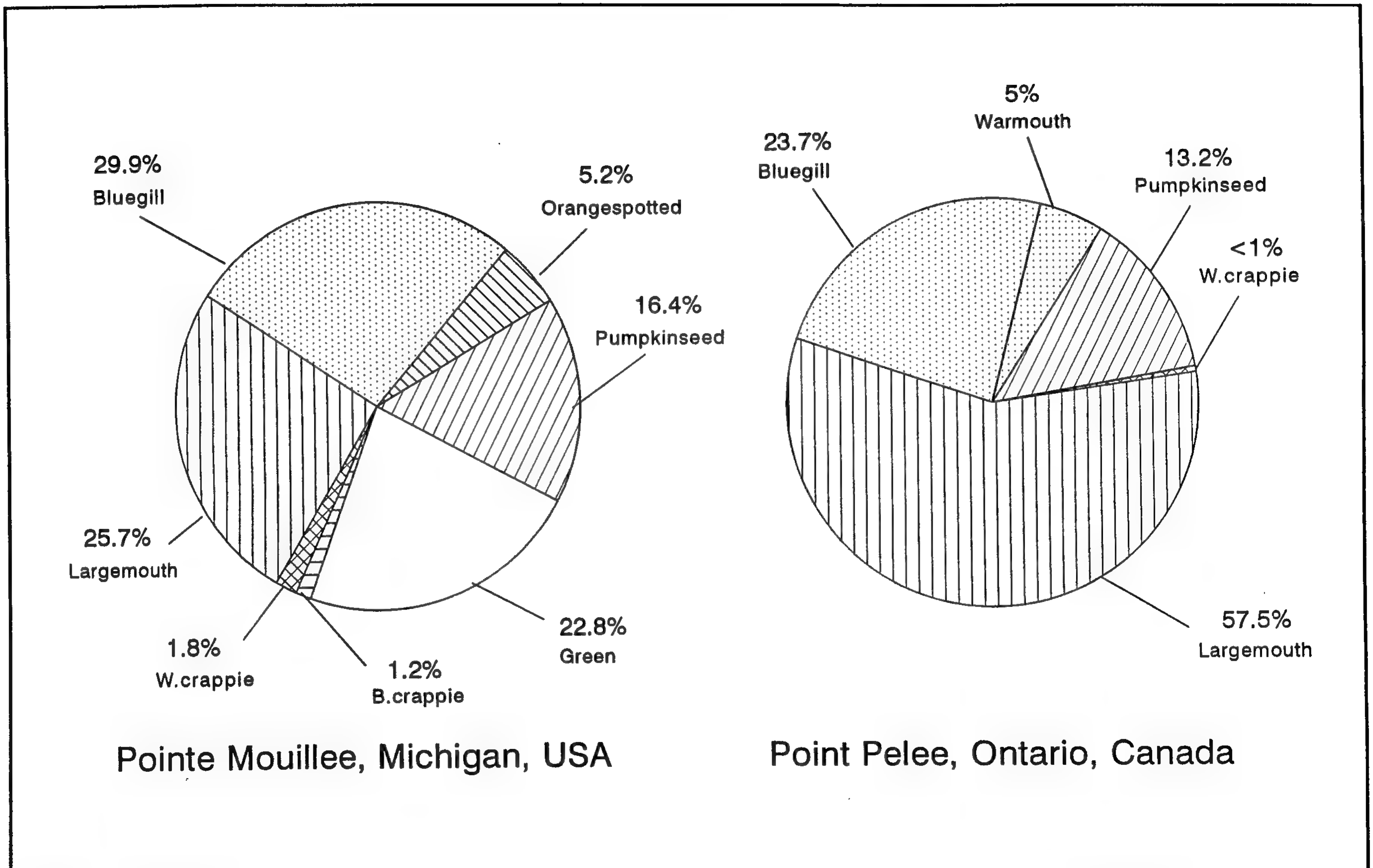

Figure 6. Differences in relative percent abundance of juvenile sunfishes (Centrarchids) between Lake Erie wetlands

Table 2
Total Numbers and Relative Percentages of Macroinvertebrates Sampled from Two Lake Erie Wetlands

Taxa	Pointe Mouillee, MI		Point Pelee, Ontario	
	(N)	(%)	(N)	(%)
(Turbellaria)				
Tricladida	1	0.01	46	0.16
(Nematoda)	3	0.03	6	0.02
(Annelida)				
Hirudinea	0	0	1	<0.01
Oligochaeta	19	0.20	68	0.23
Naididae	65	0.68	31	0.11
(Cladocera)				
Leptodora kindti	8	0.08	566	1.95
Polyphemus sp.	0	0	5	0.02
Bosminidae	651	6.78	1,454	5.01
Chydoridae	113	1.18	1,222	4.21
Eurycercus lamellatus	122	1.27	102	0.35
Daphnidae	330	3.43	3,297	11.37
Sididae	126	1.31	1,800	6.21
(Copepoda)				
Argulus sp.	9	0.09	5	0.02
Calanoida	359	3.74	990	3.41
Cyclopoida	506	5.27	702	2.42
Harpacticoida	3	0.03	37	0.13
(Ostracoda)	445	4.63	7,429	25.62
(Isopoda)				
Asellus sp.	0	0	2	0.01
(Mysidacea)				
Mysis sculatarelicta	29	0.30	3	0.01
(Amphipoda)				
Hyalella azteca	223	2.32	6,500	22.42
Gammarus fasciatus	226	2.35	33	0.12
Gammarus sp.	29	0.30	14	0.05
(Decapoda)				
Palaemonetes kadiakensis	11	0.11	46	0.16
(Hydracarina)	459	4.78	255	0.88
(Ephemeroptera)				
Caenis sp.	12	0.13	25	0.09
Ephemeroptera sp.	1	0.01	0	0
Baetidae	5	0.05	18	0.06
(Odonata)				
Aeshnidae	1	0.01	1	<0.01
Coenagrionidae	34	0.35	429	1.48
Lestidae	3	0.03	27	0.09

(Continued)

Table 2 (Concluded)

Taxa	Pointe Mouillee, MI		Point Pelee, Ontario	
	(N)	(%)	(N)	(%)
(Hemiptera)				
Belostoma sp.	1	0.01	1	<0.01
Buenoa sp.	5	0.05	42	0.15
Mesovelia sp.	0	0	1	<0.01
Notonecta sp.	2	0.02	3	0.01
Corixidae	5,146	53.56	1,599	5.51
Nepidae	1	0.01	0	0
Ranatra sp.	3	0.03	56	0.19
Nepa sp.	0	0	4	0.01
(Trichoptera)				
Oxyethira sp.	88	0.92	19	0.06
Triaenodes sp.	0	0	113	0.39
Trichoptera sp.	13	0.14	69	0.24
(Coleoptera)				
Peltodytes sp.	8	0.08	1	<0.01
Dytiscidae	11	0.11	0	0
Hydrophilidae	5	0.01	0	0
Gyrinidae	1	0.01	0	0
Dineutus sp.	0	0	2	<0.01
(Diptera)				
Chaoborus sp.	1	0.01	0	0
Odontomyia sp.	0	0	1	<0.01
Ceratopogonidae	107	1.11	228	0.79
Chironomidae pupae	111	1.16	470	1.62
Chironomini	381	3.97	990	3.41
Orthocladini	42	0.44	197	0.68
Tanypodinae	13	0.14	11	0.04
Tabanidae	1	0.01	0	0
(Gastropoda)				
Physidae	75	0.78	38	0.13
Planorbidae	26	0.27	39	0.14
Totals	9,608		28,998	

Microhabitat

Only two physical variables, temperature and pH, did not differ significantly between the two wetlands (Table 3), although variation in some parameters was substantial (Table 4). Turbidity and distance from shore were highly variable (coefficient of variation > 70 percent). Cover, total dissolved solids, depth, temperature, and dissolved oxygen were moderately variable (coefficient of variation 47-24 percent). There was little variation in pH (coefficient of variation = 4 percent). Mean conditions for light traps were moderate distances from shore (5.6 m), in water that was shallow (0.7 m), cool (18 ºC), alkaline (ph = 8.4), and well-oxygenated (D.O. = 8.5 mg/l); turbidity (58.2 NTU's) and total dissolved solids (170 ppm) were moderate.

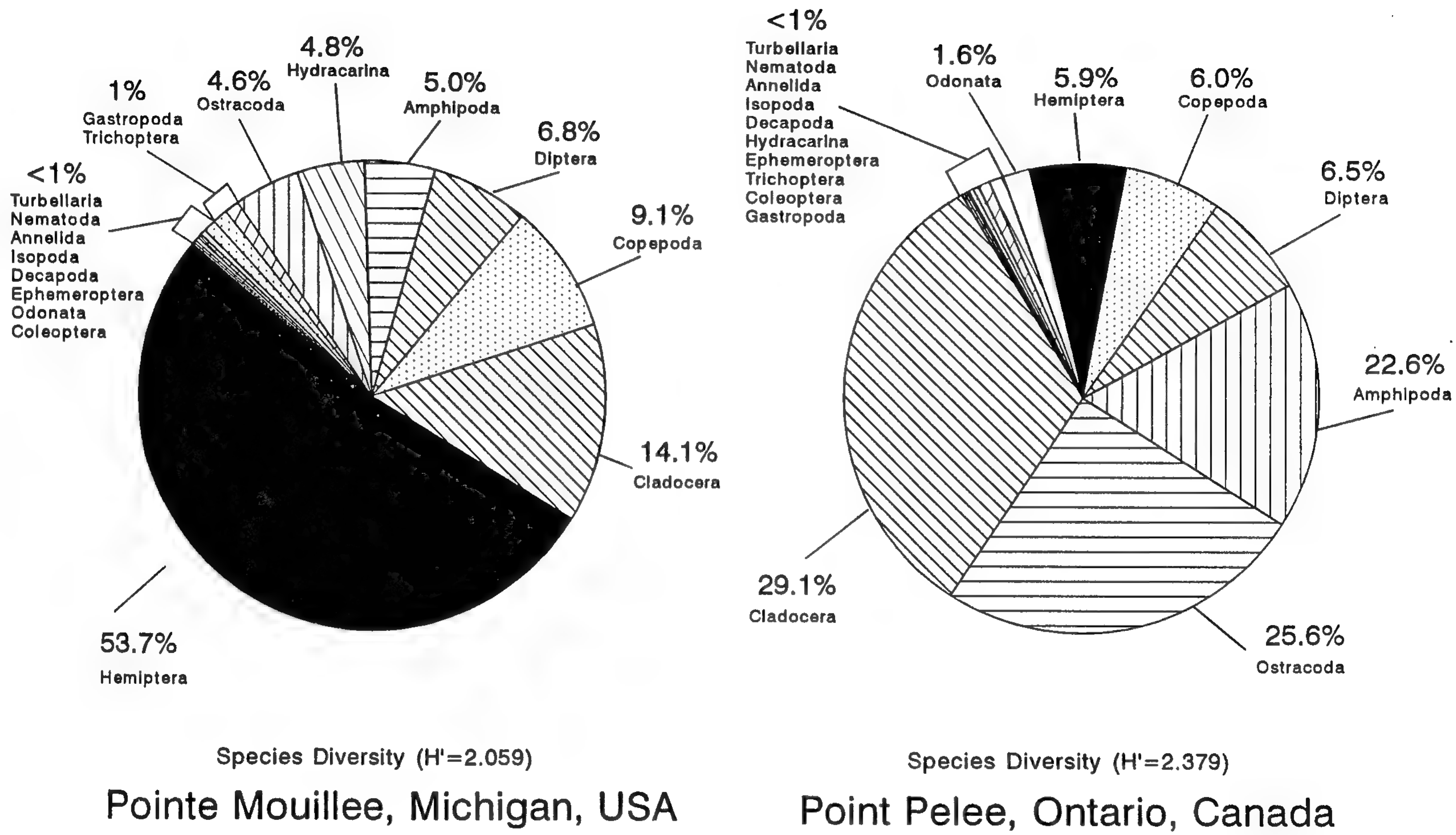

Figure 7. Differences in relative percent abundance of macroinvertebrates between Lake Erie wetlands

Table 3
Comparison of Microhabitat Variables Between the Lake Erie Wetlands (Values are expressed as means and N = 40 for each parameter except plant cover, which was expressed as a percentage and N = 160)

Microhabitat Variable	Wetland Study Site		F-value	P
	Pointe Mouillee	Point Pelee		
Water temperature (°C)	18.2	17.4	0.2	>0.05
Water depth (m)	0.60	0.80	26.9	<0.001
Distance from shore (m)	6.9	4.2	5.2	<0.05
Water clarity (cm)	14.8	77.4	61.9	<0.001
Water turbidity (*NTU's*)	90.8	26.1	25.5	<0.001
Dissolved oxygen (ppm)	9.5	7.3	17.1	<0.001
Total dissolved solids (ppm)	226.9	107.0	200.9	<0.001
pH	8.5	8.3	3.0	>0.05
Plant cover (%)	57.4	76.8	4.2	<0.05

Pointe Mouillee was more turbid and lower in clarity than Point Pelee. Turbidity ranged from 3.4 *NTU's* at Point Pelee to 194.0 *NTU's* at Pointe Mouillee. Mean turbidity at Pointe Mouillee was 90.8 *NTU's* and only 26.1 *NTUs* at Point Pelee, which differed significantly ($F=26.9$, $P<0.001$). Likewise, difference in water clarity was significant ($F=61.9$, $P<0.001$) between the wetlands.

Abundance of plant cover varied among trap stations (Table 3). Mean percentage of plant cover at stations significantly varied between wetlands ($F = 4.2$, $P<0.05$). Eleven stations at Pointe Mouillee contained <50 percent plant cover and four of these contained no plant cover. All stations at Point Pelee contained plants and only seven stations contained <50 percent plant cover (Table 4). Plant species richness was higher at Point Pelee than at Pointe Mouillee. Only six species of aquatic plant were sampled in stations at Pointe Mouillee, whereas, 18 different aquatic plants were found growing in trap stations at Point Pelee (Table 5).

Principal component analysis (PCA) suggested much of this variation in microhabitat data collected was due to temporal differences in season and spatial variation between sites (Figure 8). Two principal components (PC 1, and PC 2) accounted for 59.7 percent of the total variance in microhabitat data collected at both wetlands. Variation in depth, turbidity, and total dissolved solids (TDS) were most important between wetlands, and temperature, pH, and percent plant cover varied most between April and June sample periods (Figure 8).

Table 4
Differences in Mean Values of Microhabitat Parameters Recorded at Trap Stations During April and June Sample Periods (1993) between Pointe Mouillee, Michigan, USA, and Point Pelee, Ontario, Canada Wetlands

Stations	Temperature (°C)	Depth (m)	Distance (m)	Secchi (cm)	Turbidity (NTUs)	DO (ppm)	TDS (ppm)	pH	Plants (%)
Pointe Mouillee									
(April)									
1	11.0	1.0	3.9	38.7	35.0	8.0	260.0	8.1	64.3
2	12.0	0.6	3.1	15.4	133.0	9.0	220.0	8.0	0
3	12.0	0.4	1.7	15.4	86.5	9.0	230.0	8.3	0
4	12.0	0.7	7.0	26.9	55.1	7.3	245.0	8.2	83.3
5	12.0	0.5	4.2	25.6	85.4	7.5	255.0	8.5	100.0
6	12.0	0.4	7.1	15.4	135.2	9.7	250.0	8.8	58.3
7	12.0	0.5	5.9	15.4	112.0	10.0	255.0	8.9	50.0
8	12.0	0.5	8.3	15.4	114.0	10.0	260.0	8.9	100.0
9	12.0	0.4	8.3	15.4	159.5	10.0	260.0	8.9	66.7
10	12.0	0.4	6.4	15.4	194.0	10.0	260.0	9.0	50.0
11	11.3	0.5	7.2	15.4	170.7	10.0	260.0	8.6	50.0
(June)									
1	24.0	0.5	11.4	11.8	50.9	11.5	200.0	8.9	50.0
2	25.5	0.4	21.9	14.4	129.0	9.0	215.0	8.3	50.0
3	27.0	0.6	13.7	9.7	61.4	9.0	205.0	8.1	50.0
4	22.5	0.5	9.8	17.4	64.5	6.8	230.0	8.0	0
5	26.5	0.9	3.7	6.9	84.0	9.5	215.0	7.9	83.3
6	27.5	0.7	4.8	5.4	12.2	13.0	175.0	8.7	100.0
7	25.5	0.5	3.8	11.0	79.7	10.8	195.0	8.7	100.0
8	27.0	0.6	3.1	5.6	12.9	13.5	180.0	8.2	0
9	19.5	0.7	5.9	12.3	44.4	9.0	175.0	8.4	50.0
10	27.0	0.6	3.4	2.1	87.4	7.5	220.0	8.1	100.0

(Continued)

Table 4 (Concluded)

Stations	Temperature (°C)	Depth (m)	Distance (m)	Secchi (cm)	Turbidity (NTUs)	DO (ppm)	TDS (ppm)	pH	Plants (%)
Point Pelee									
(April)									
1	13.5	0.9	2.0	94.6	24.4	8.3	163.0	8.6	100.0
2	11.5	0.9	1.1	141.0	5.7	6.5	100.0	8.5	100.0
3	12.0	1.2	4.7	134.6	4.4	7.0	95.0	8.5	100.0
4	12.0	1.0	2.8	115.4	7.3	8.0	105.0	8.6	100.0
5	11.6	1.0	1.7	71.8	14.0	9.0	125.0	8.5	100.0
6	11.0	0.8	2.4	51.3	19.3	9.0	125.0	8.4	50.0
7	11.0	0.7	3.4	56.4	17.3	9.5	120.0	8.4	50.0
8	11.0	0.8	3.6	66.7	15.7	9.8	120.0	8.2	83.3
9	12.0	0.6	7.5	40.3	52.1	8.3	115.0	8.3	50.0
10	12.6	0.5	8.4	16.4	85.5	7.4	114.0	8.6	60.0
(June)									
1	22.3	0.6	10.2	23.1	83.9	7.0	95.0	8.0	50.0
2	23.3	0.5	6.0	62.8	46.0	7.3	85.0	8.3	50.0
3	22.0	0.9	2.6	44.9	26.6	4.8	145.0	8.0	100.0
4	22.5	1.2	1.7	77.7	3.4	6.8	80.0	8.0	66.7
5	23.4	1.0	6.9	68.5	54.5	4.9	91.0	7.8	50.0
6	24.0	1.4	1.0	100.0	15.4	3.5	85.0	7.6	100.0
7	23.5	1.1	3.1	92.3	5.0	7.8	80.0	8.2	50.0
8	24.5	1.1	5.1	89.7	10.0	5.3	95.0	8.0	100.0
9	26.5	1.0	5.1	123.1	5.4	8.3	95.0	8.6	100.0

Table 5
Common Aquatic Plants Sampled at Stations Located in Lake Erie Wetland Study Sites (X = present; 0 = absent)

Species[1]	Study Site	
	Pointe Mouillee	**Point Pelee**
Brasenia schreberi	0	X
Ceratophyllum demersum	0	X
Elodea canadensis	X	X
Justicia americana	0	X
Myriophyllum verticulatum	X	X
Megalodonta beckii	0	X
Nuphar spp.	0	X
Nymphaea odorata	0	X
Nymphoides spp.	0	X
Potamogeton amplifolius	0	X
Potamogeton crispus	X	X
Potamogeton illinoensis	0	X
Potamogeton natans	0	X
Potamogeton pectinatus	X	0
Potamogeton richardsonii	0	X
Potamogeton spp.	0	X
Potamogeton zosteriformis	X	0
Utricularia spp.	X	X

[1]Species identification was based on Muenscher (1969), and Prescott (1980).

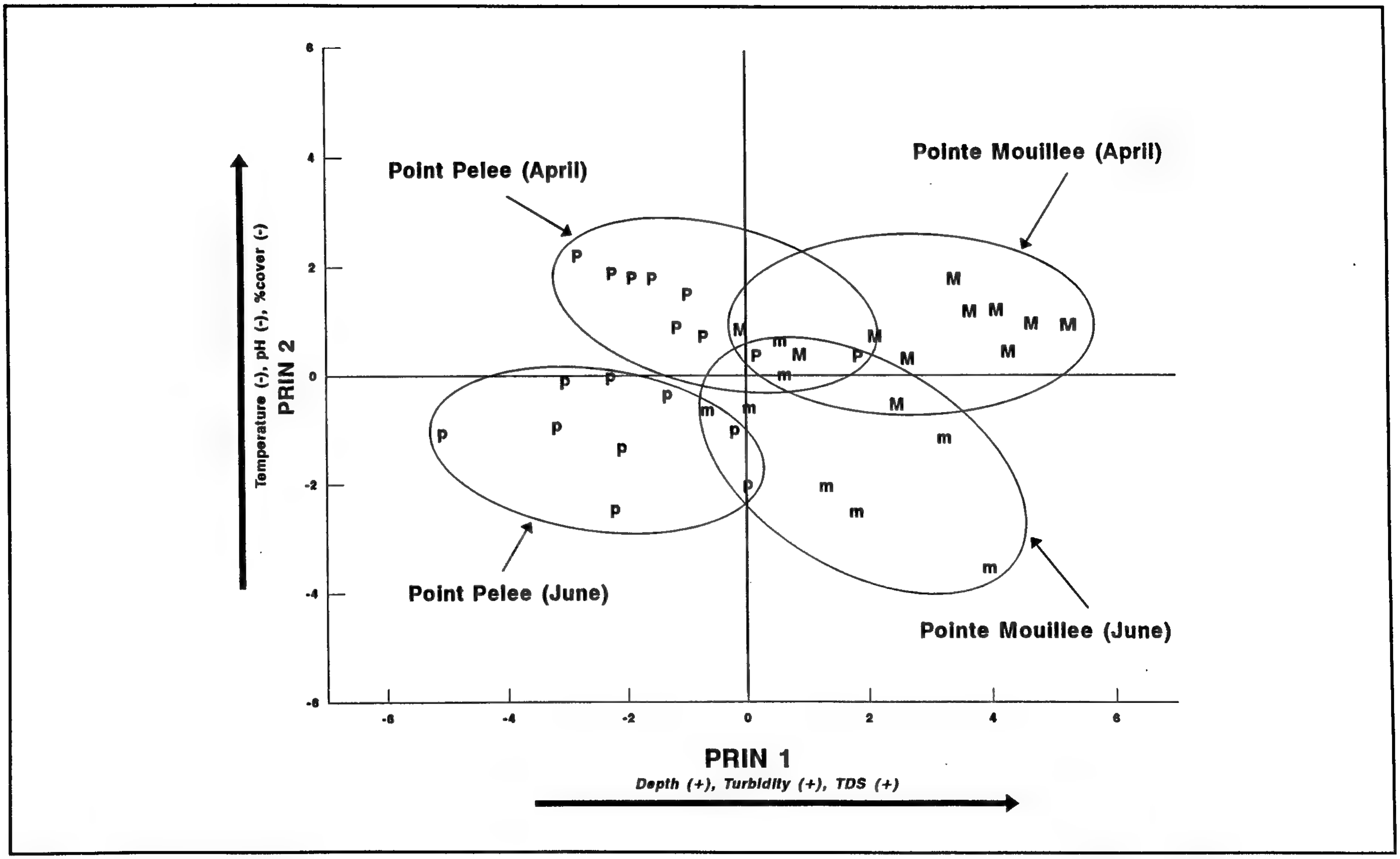

Figure 8. Principal component analysis (PCA) ordinations of physical parameters measured in sample stations at the two Lake Erie wetlands

5 Discussion

Microhabitat

Pointe Mouillee wetland is more turbid than Point Pelee, primarly due to differences in water depth, size of watershed, and extensiveness of aquatic plants. For example, water depths at Pointe Mouillee were consistently shallower than at Point Pelee. Bottom and shoreline sediments are more likely to become suspended in shallow systems where wind can create currents that mix these sediments (Losee and Wetzel 1988, 1993).

Pointe Mouillee also has a more extensive and complex watershed than Point Pelee, and the two rivers draining into Pointe Mouillee may impact turbidity. Stream and river currents, especially during floods, keep sediments suspended and turbidity high (Viessman et al. 1977). No streams empty near Point Pelee wetlands, and suspended sediments are low. Nutrients from terrestrial runoff also increase turbidity by increasing phytoplankton populations (Carpenter 1980). We did not directly measure nutrients and terrestrial runoff, but the small size of the watershed probably reduces the amount of nutrients entering wetlands at Point Pelee and may in part account for relatively low turbidity. Sample stations at Point Pelee located closer to agricultural fields, however were more turbid, suggesting possible agricultural seepage of nutrients.

In addition to increased depths and smaller sized watershed, aquatic plant cover was more extensive and diverse at Point Pelee than in wetlands at Pointe Mouillee. This may account for difference in turbidities between the two wetlands, because aquatic plants decrease turbidity by acting as wind breaks, thus reducing the magnitude of winds that create sediment mixing currents (Losee and Wetzel 1988). Plants also actively utilize nutrients that impact algae levels and filter suspended particles that increase turbidity (Gregg and Rose 1982, Carpenter and Lodge 1986, Chen and Barko 1988).

Fish Assemblages

Differences in fish composition can be attributed, in part, to differences in water quality, aquatic plant cover, and available river systems between wetlands. Point Pelee has low turbidity, high abundances, and diversity of aquatic plants, with no major river or stream drainage. Pointe Mouillee is highly turbid, relatively low in abundance and diversity of plants, and has two river systems entering the wetland.

Our data suggest wetland differences in water quality may influence composition of young fish assemblages in the two wetlands. Higher numbers of fishes that tolerate high turbidity were collected at Pointe Mouillee. For example, relatively high numbers of gizzard shad were sampled at Pointe Mouillee, whereas low numbers were sampled at Point Pelee. These clupeids typically inhabit warm sluggish backwaters with high plankton production and high turbidities (Lee et al. 1980, Robinson and Buchanan 1988).

Common carp and goldfish were more frequently sampled in wetlands at Pointe Mouillee than at Point Pelee, and both species are very tolerant of high turbidity and polluted habitats (Lee et al. 1980, Edwards and Twomey 1982, Robinson and Buchanan 1988). Carp and goldfish may also impact turbidity levels at Pointe Mouillee because while feeding on zooplankton and insect larvae near the bottom, they resuspend sediments (Carlander 1969). Bluntnose and fathead minnows, both bottom detritus feeders and tolerant of polluted and turbid waters (Lee et al. 1980), were more abundant in Pointe Mouillee samples. Quillback, buffalo, and green sunfish are other bottom feeding species tolerant of high turbidity (Lee et al. 1980, Edwards 1983). These species were more prevalent in Pointe Mouillee in samples from wetlands at Point Pelee.

Cyprinid species were less common at Pointe Pelee, except for golden shiner. The golden shiner typically inhabits quiet waters and thrives in clear, highly vegetated habitats (Scott and Crossman 1973, Pflieger 1975). In addition, this species is a surface and midwater feeder (Keast and Webb 1966), and water clarity may be important for efficient foraging. Water clarity is also important to largemouth bass, which were more abundant at Point Pelee. Largemouth bass are visually oriented (Nyberg 1971), which may increase efficiency in behaviors important to their survival, i.e., predator avoidance, nest guarding, parental care, and foraging (Miller 1979).

Differences between wetlands in abundances of riverine and large water fishes also were noted. This suggests that the Huron and Mouillee Rivers emptying Pointe Mouillee wetlands may increase abundance of riverine fishes by providing additional habitat not present at Point Pelee. For example, most suckers of the genus *Moxostoma* are found in swift steams and rivers (Pflieger 1975, Lee et al. 1980), and larvae of this genus were collected at Pointe Mouillee, but not in wetlands at Point Pelee.

Likewise, the emerald shiner, a species of large lake and river systems (Lee et al. 1980), was found at Pointe Mouillee but was conspicuously absent from wetlands at Point Pelee.

Our data agree with others that availability of extensive aquatic plant beds influence abundance and diversity of fishes in wetlands (Poe et al. 1986), and like other wetlands, young fishes benefit from dense submersed vegetation (Chubb and Liston 1986). Grass pickerel, central mudminnow, and largemouth bass, all phytophilic species, were more common at Point Pelee than Pointe Mouillee. Grass pickerel typically inhabit shallow clear water habitats that are heavily vegetated (Pflieger 1975, Lee et al. 1980, Robison and Buchanan 1988). The central mudminnow feeds on Copepoda, Ostracoda, and Cladocera in highly vegetated habitats (Peckham and Dineen 1957). Correspondingly, Cladocera and Ostracoda were prevalent macroinvertebrates at Point Pelee.

Compared to Pointe Mouillee, high abundances and diversity of macroinvertebrates at Point Pelee are attributed to high diversity of aquatic plants. Others have demonstrated that diversity of aquatic plants enhances diversity and abundance of invertebrate prey for young fishes, which in turn increases abundance of young fishes (Pardue and Nielsen 1979, Keast 1985). Complexity of vegetated areas serves as good habitat for invertebrates and increases their diversity and abundances which supply important food resources for young fishes (Pardue and Nielsen 1979, Gilinsky 1984, Keast 1985). Because of this, aquatic plant habitats are important to the growth and survival of many young fishes by supplying forage and refuge sites (Boyd 1971, Mittelbach 1981, Crowder and Cooper 1982, Paller 1987). Thus, a higher number of young fishes in Point Pelee wetlands would be expected because of the higher diversity of aquatic plants and higher abundance and diversity of invertebrates. However, Point Pelee had lower abundance of fishes than Pointe Mouillee. It is possible that the aquatic plant habitat at Pointe Pelee decreases fish abundance because foraging efficiency is reduced in structurally complex habitats (Crowder and Cooper 1982). Further study would be needed to investigate this hypothesis.

Conclusions and Recommendations

Differences in certain microhabitat variables (i.e., turbidity) and in species composition and abundance of aquatic plants were associated with differences in composition of the fish assemblages at two Lake Erie wetlands. This concurs with previous wetland studies indicating that abundance and diversity of aquatic plants are important in affecting fish communities. Poe et al. (1986) suggest that as wetlands become more altered by human activities, fish communities may shift in species composition, because preferences for diverse habitats were higher by one species and tolerance to habitat alteration lower by others. Thus, loss of Great

Lake wetlands has important implications for Great Lake coastal fish communities (Chubb and Liston 1986).

This study provides a new database to more thoroughly assess restoration and status of fish communities in these two wetlands. Pointe Mouillee and Point Pelee represent some of the last remaining wetlands along Lake Erie shorelines and if opened to the main lake may serve as critical nursery habitat for Great Lake fishes. Similar wetlands serve as important nurseries for Great Lake fishes (Chubb and Liston 1986). Until now, little was known about larval and juvenile fishes in wetlands at Pointe Mouillee and Point Pelee. Continued study of young fishes and their use of habitat in these and other wetlands are essential for thorough evaluation of wetland restoration and understanding the ecological importance of Lake Erie wetlands.

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Eric D. Dibble, Jan J. Hoover, Mary C. Landin

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13. ABSTRACT *(Maximum 200 words)*

Composition of larval and juvenile fishes and macroinvertebrates was compared between two Lake Erie Wetlands: Pointe Mouillee, MI, USA, and Point Pelee, Ont., Canada. Light traps (232 trap nights) were used to measure abundance and diversity of larval fishes and macroinvertebrates, and seines were used to quantify juvenile fish abundance. Samples were collected during (April and June 1993, June 1994). A total of 9,608 invertebrates was sampled at Pointe Mouillee and 28,998 at Point Pelee; 1,910 larval and 1,229 juvenile fishes were collected at Pointe Mouillee and 395 larval and 1,052 juvenile fishes at Point Pelee. Abundance and diversity of larval fishes significantly differed ($F = 2.5$, $P < 0.05$) between Pointe Mouillee and Point Pelee wetlands. Significant differences ($F = 3.47$, $P < 0.01$) in abundance of juvenile fishes also were noted, yet diversities were similar. Minnows (Cyprinidae) and perch (Percidae) dominated Pointe Mouillee collections, whereas, sunfishes (Centrarchidae) constituted > 55 percent of all fishes collected at Point Pelee. Macroinvertebrate diversity was slightly higher at Point Pelee: 49 taxa ($H' = 2.307$) compared to 48 taxa ($H' = 2.056$) at Pointe Mouillee. Hemiptera dominated the Pointe Mouillee sample, and Cladocera, Ostracoda, and Amphipoda constituted much of the Point Pelee sample. Difference in fish composition between the two wetlands was attributed to turbidity, plant cover, and available river systems.

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Juvenile fishes	Turbidity
Larval fishes	Water quality
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